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Anaerobic Digester Optimization with Bio-Organic Catalyst®

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One Year Study November '07 - November '08

NON-TOXIC AND SAFE
BIO-ORGANIC SEAL OF SAFETY
HUMAN, ANIMAL & MARINE LIFE

Municipal Anaerobic Digester Optimization Program Index

- Overview Ridgewood Water Pollution Control Facility (WPCF)
- Description of Operating Baselines:
  - Biogas Production
  - Sludge Volumes
  - Secondary Aeration Energy Usage
- Anaerobic Digestion Optimization with BOC
- Summary & Potential Economic Values

Water Pollution Control Facility Ridgewood, N.J.

The Village of Ridgewood located in Bergen County, New Jersey, is the fourth largest community in Bergen County, with a population of 25,500 and land area of 5.79 square miles.

The Department of Public Works - Division of Water Pollution Control, operates the wastewater treatment plant (WPCF) and the sewage collection system.

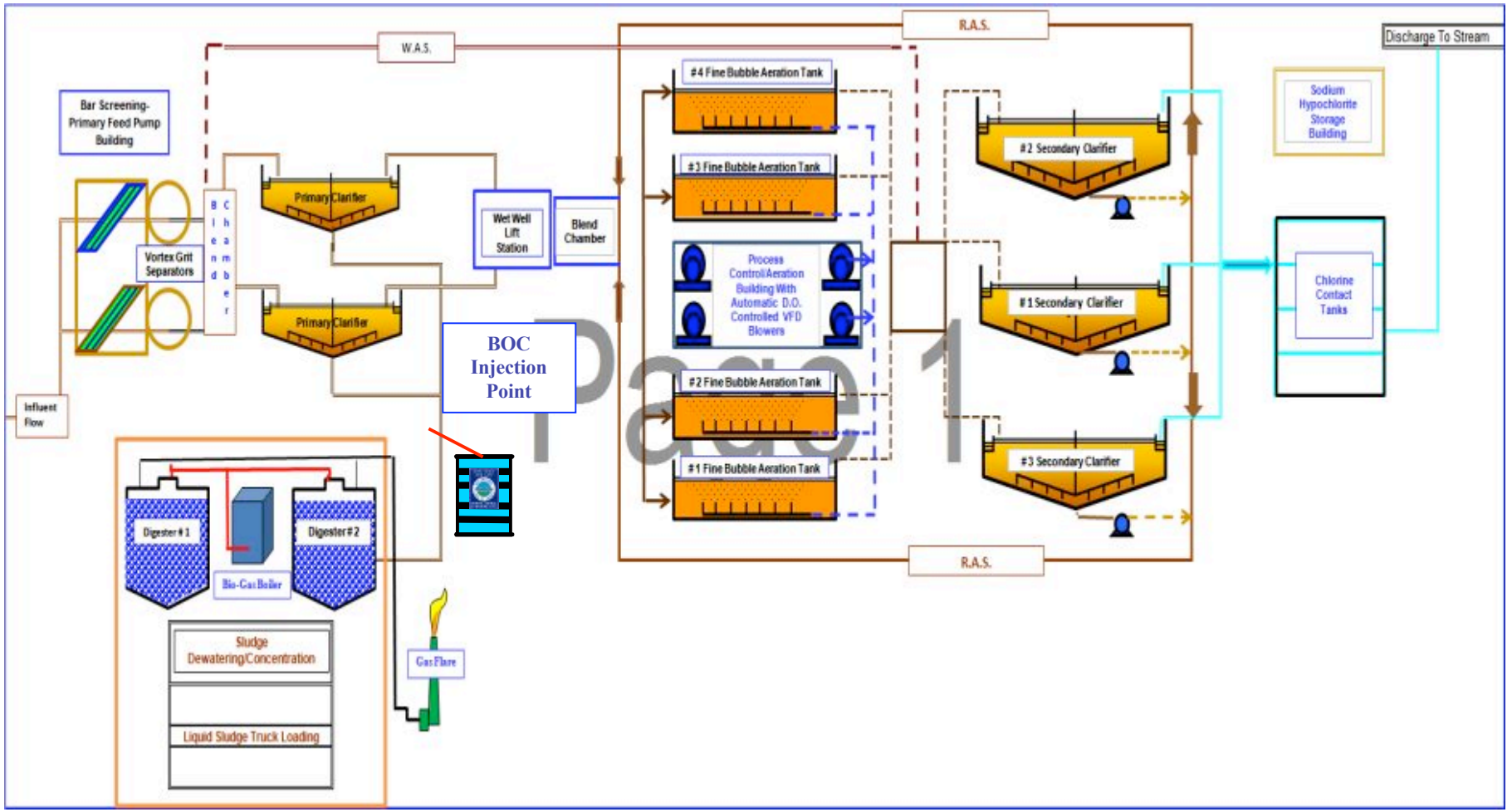
The Ridgewood, NJ WPCF receives an average daily flow of 2.6 - 3.0 MGD.

The sewage collection system is 92 miles in length, a combination of gravity and force mains. The lines range from 8 inches to 30 inches in diameter.

There are 6 pumping stations which pump influent flow into the WPCF.

The WPCF is operated as an activated sludge plant: with primary clarifiers, secondary aeration, secondary clarifiers, and anaerobic digester. It concentrates digested sludge prior to sending it off-site for incineration.

Ridgewood NJ WPCF Layout and BOC Injection Point



Ridgewood NJ WPCF Anaerobic Digestion (AD) System

- The anaerobic digester functions in the mesophilic temperature range of 38.3º C/101ºF.
- The anaerobic digester has a volume of 500,000 gallons/1893 cubic meters.
- The baseline average primary feed sludge loading was 27,500 gallons /104 cubic meters daily.
- The average HRT was 18.3 days.
- Biomethane generated is burned in a boiler to heat incoming primary feed sludge and to maintain the digester temperature. Excess biomethane is flared off.
- The clear liquid "supernatant" is withdrawn from the top of a 500,000 gallons/1893 cubic meter holding tank and recycled to the influent wet well.

Analytical Values of Anaerobic Digestion during BOC Optimization Program

Anaerobic Digestion analytical values:

Biomethane yields;

- **Per cubic feet ($CuFt^3$)**
- **Per lb. of T.S. & T.V.S.**
- **Per gal. of primary feed sludge.**
- **Per 100 gals. of influent flow.**

- **Reduction/replacement in the consumption of natural gas in boiler heating anaerobic digesters (AD).**
- **Reduction of digester sludge volumes and weight.**
- **Reduction of aeration energy consumption in secondary aeration channels, i.e. energy used (kWh/Lb of $CBOD_5$).**
- **Reduction of volatile organics for odor reduction in digester dewatering operation and dewatered sludge.**

Operating Baseline Values & BOC Injection Period

Comparison Of Baseline Values & BOC Injection Period

Comparison Of Baseline vs. Optimum BOC Injection Period			Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	% Increase (Decrease) Over Baseline	Notes
Influent Flow & Load	FLOW	Influent Flow-MGD	3.45	2.45	-28.9%	Decreased
		Influent Flow-100 GPD	34,510	24,559	-28.9%	Decreased
		Influent Flow-m^3/day	13,063	9,285	-28.9%	Decreased
	TEMPERATURE	TEMP.Daily Aver.-^{0}C	19.1	17.9	-6.5%	Decreased
	$CBOD_5$	Influent CBOD5-mg/L	194.9	202.0	3.6%	Increased
	T.S.S	T.S.S.-mg/L	232.3	266.3	14.7%	Increased
	AMMONIA-N	AMMONIA-N-mg/L	10.9	18.5	70.9%	Increased
	TOTAL P	TOTAL P-mg/L	4.89	6.3	28.8%	Increased
	GRIT REMOVAL	Cubic Feet Per Month	259	367		
PRIMARY EFFLUENT	$CBOD_5$	Primary Effluent $CBOD_5$-mg/L	83.1	84.8	2.1%	Increased
	T.S.S	T.S.S.-mg/L	99.6	102.0	2.5%	Increased
	$CBOD_5$	% Removal Of CBOD5 (Infl. vs.. Primary Effluent)	56.2	57.9	2.9%	Improved
	T.S.S	% Removal Of T.S.S.- (Infl. vs.. Primary Effluent)	56.3	61.0	8.3%	Improved

Plant Effluent-Comparison Of Baseline Values & BOC Injection Period

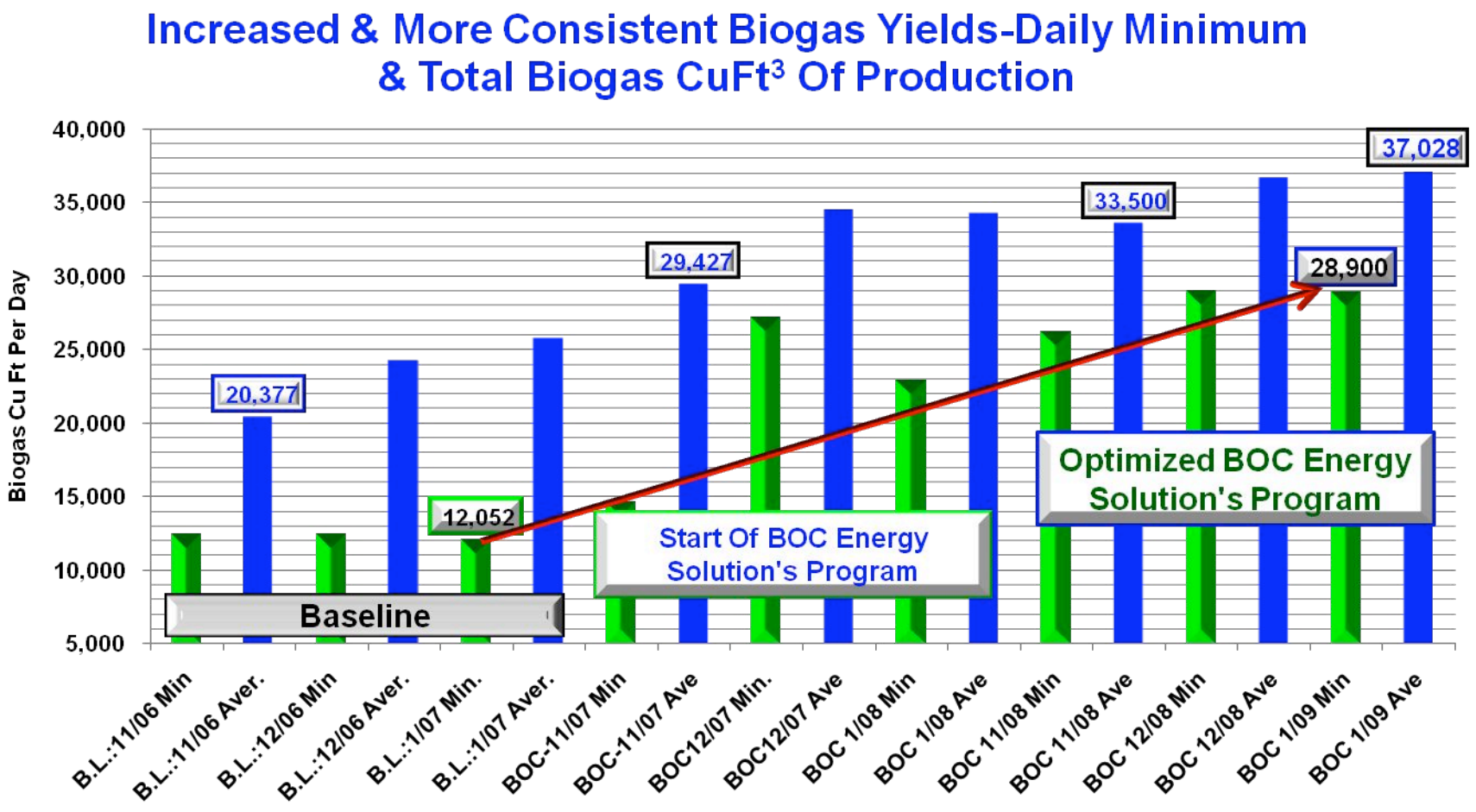
Comparison Of Baseline vs. Optimum BOC Injection Period			Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	% Increase (Decrease) Over Baseline	Notes
PLANT EFFLUENT	$CBOD_5$	Plant Effluent $CBOD_5$-mg/L	7.0	6.3		
		$CBOD_5$ Removal % (Influent vs.. Effluent)	96.1%	96.8%	0.7%	Improved
	T.S.S	T.S.S.-mg/L	6.4	6.9		
		T.S.S.-Removal % (Influent vs.. Effluent)	97.3%	97.4%	0.1%	Improved
	D.O.	D.O.-mg/L	6.69	6.90	3.1%	Improved
	AMMONIA-N	AMMONIA-N-mg/L	1.21	1.07		
		AMMONIA-N-Removal % (Influent vs.. Effluent)	88.9	94.4	6.3%	Improved
	TOTAL P	TOTAL P-mg/L	2.9	3.5		
		TOTAL P-Removal % (Influent vs.. Effluent)	40.6	42.7	4.7%	Improved

Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	% Increase (Decrease) Over Baseline	Notes
Daily Ave- $CuFt^3$ Of Bio Gas Produced	21,518	34,958	62%	Increased
HRT-Days	18.4	16.5	*11.5%*	*Decreased*
$CuFt^3$ of Biogas /Day Of HRT	1,167	2,328	99.5%	Increased
% TS Reduction-Aver. (Max)	17.9%	27.2% (65%)	52%	Increased
% TVS Reduction-Aver. (Max)	49.6%	54.0% (75%)	8.9%	Increased
T.S. Yield : $CuFt^3$ of Biogas per Lb removed	8.5	15.9	87.1%	Increased
T.V.S. Yield : $CuFt^3$ of Biogas per Lb removed	9.0	14.3	58.9%	Increased
Yield Of Biogas- $CuFt^3$ / 100 Gal Of Influent Flow	.68	1.39	105%	Increased

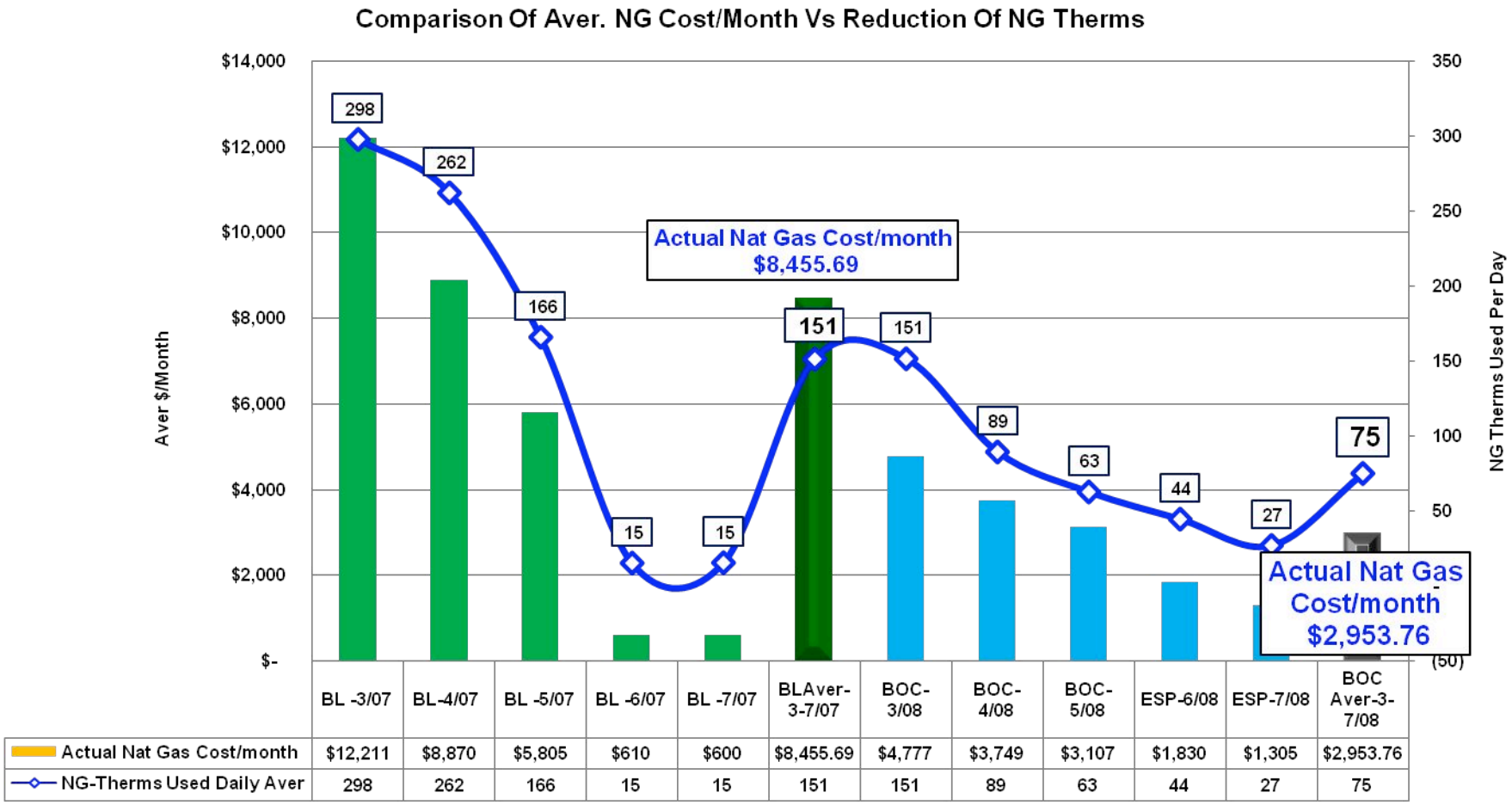
Minimum & Daily Average Biomethane Production ($CuFt^3$)



Biomethane-Comparison Of Baseline Values & BOC Injection Period

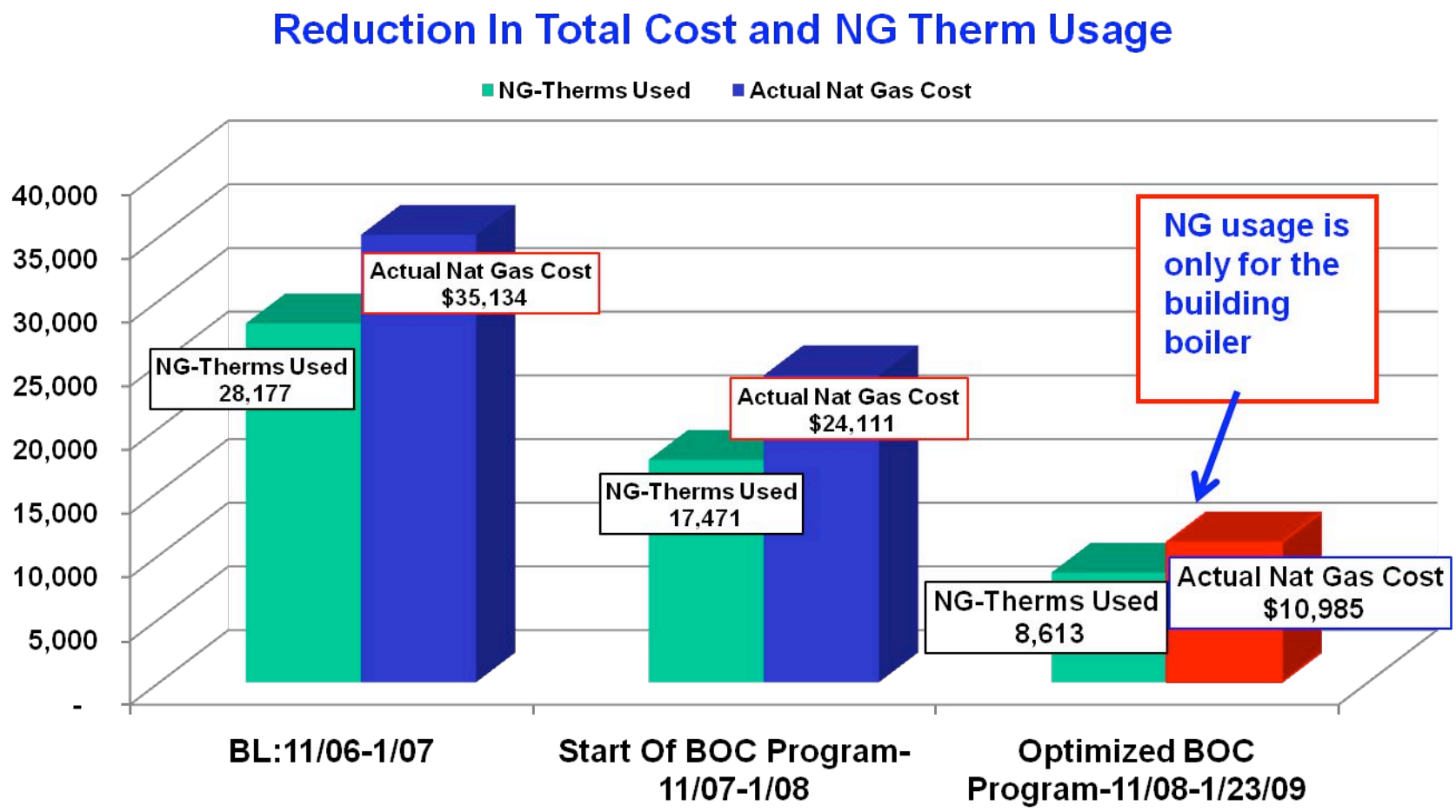
Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 3/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	% Increase (Decrease) Over Baseline	Notes
Gallons of primary sludge to AD-daily average	27,172	32,433	19%	Increased
Daily average-cu ft^3 of biogas produced	21,518	34,958	62%	Increased
Cu Ft^3 Of bio-gas required heat primary feed sludge to aver. AD Temp. @ 600 BTU's / Cu Ft^3	16,200	15,676	-3%	Decreased
Daily Ave-BTU's of biogas produced	10,759,238	20,975,012	95%	Increased
Daily BTU's required heat primary feed sludge to aver. AD temp.	8,100,070	9,405,563	16%	Increased
Excess biogas BTU's produced	2,659,168	11,569,450	335%	Increased
Excess daily Cu Ft^3 of biogas produced to heat primary feed sludge to correct aver. A.D Temp.	5,318	19,282	263%	Increased

Reduction Of NG Cost/ Month & Therm Usage with BOC Optimization



	BL -3/07	BL-4/07	BL -5/07	BL -6/07	BL -7/07	BLAver-3-7/07	BOC-3/08	BOC-4/08	BOC-5/08	ESP-6/08	ESP-7/08	BOC Aver-3-7/08
Actual Nat Gas Cost/month	$12,211	$8,870	$5,805	$610	$600	$8,455.69	$4,777	$3,749	$3,107	$1,830	$1,305	$2,953.76
NG-Therms Used Daily Aver	298	262	166	15	15	151	151	89	63	44	27	75

Reduction In Total Cost and NG Therm Usage



Comparison of Baseline Values & Lower NG Usage and Cost

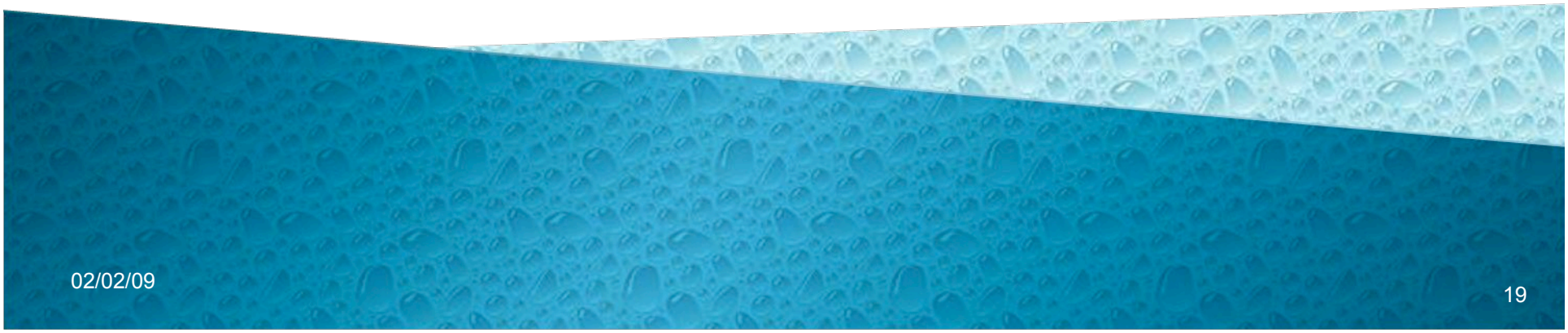
Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 11/06-5/07	BOC Optimum Injection Period Aver.-11/07-5/08	% Increase (Decrease) Over Baseline	Notes
Daily BTU's required to heat primary feed sludge to aver. AD temp.	8,100,070	9,405,563	16%	Increase
Excess daily cu ft of biogas produced to Heat Primary Feed Sludge To Aver. AD Temp	5,318	19,282	263%	Increase
NG-Therms used daily aver.	151	75	101%	Decrease
NG-Therms/ M gallons of primary feed sludge	5.42	2.34	132%	Decrease
Aver.-Nat Gas Cost/month	$ 8,455.69	$ 2,953.76	186%	Decrease
Excess daily biogas BTU's produced	2,659,168	11,569,450	335%	Increase

Reduction Of Sludge Volumes

Comparison of Sludge Baseline Values & BOC Injection Period

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	% Increase (Decrease) Over Baseline	Notes
Influent Flow-MGD	3.45	2.45	-28.9%	Decreased
Primary Feed Gallons Per Gallon of Influent Flow	0.0085	0.0128	33.4%	Increased
% Waste Haulage Gallons Vs Primary Feed Gallons	12.2%	9.1%	25.2%	Decreased
Primary Feed Sludge (GPD)	27,426	32,216	15%	Increased
Primary Feed Sludge % T.S.	1.88%	1.81%	3.8%	Decreased
Primary Feed Sludge % T.V.S.	85.65%	85.21%	.5 %	Decreased
Sludge Haulage daily gallon aver	3,166	2,713	14.3%	Decreased
Actual Sludge Haulage Volume reduction (Corrected for increased AD loading)			29.3%	Decreased

Reduction Of Secondary Aeration Energy



Reduction Of Secondary Aeration Energy

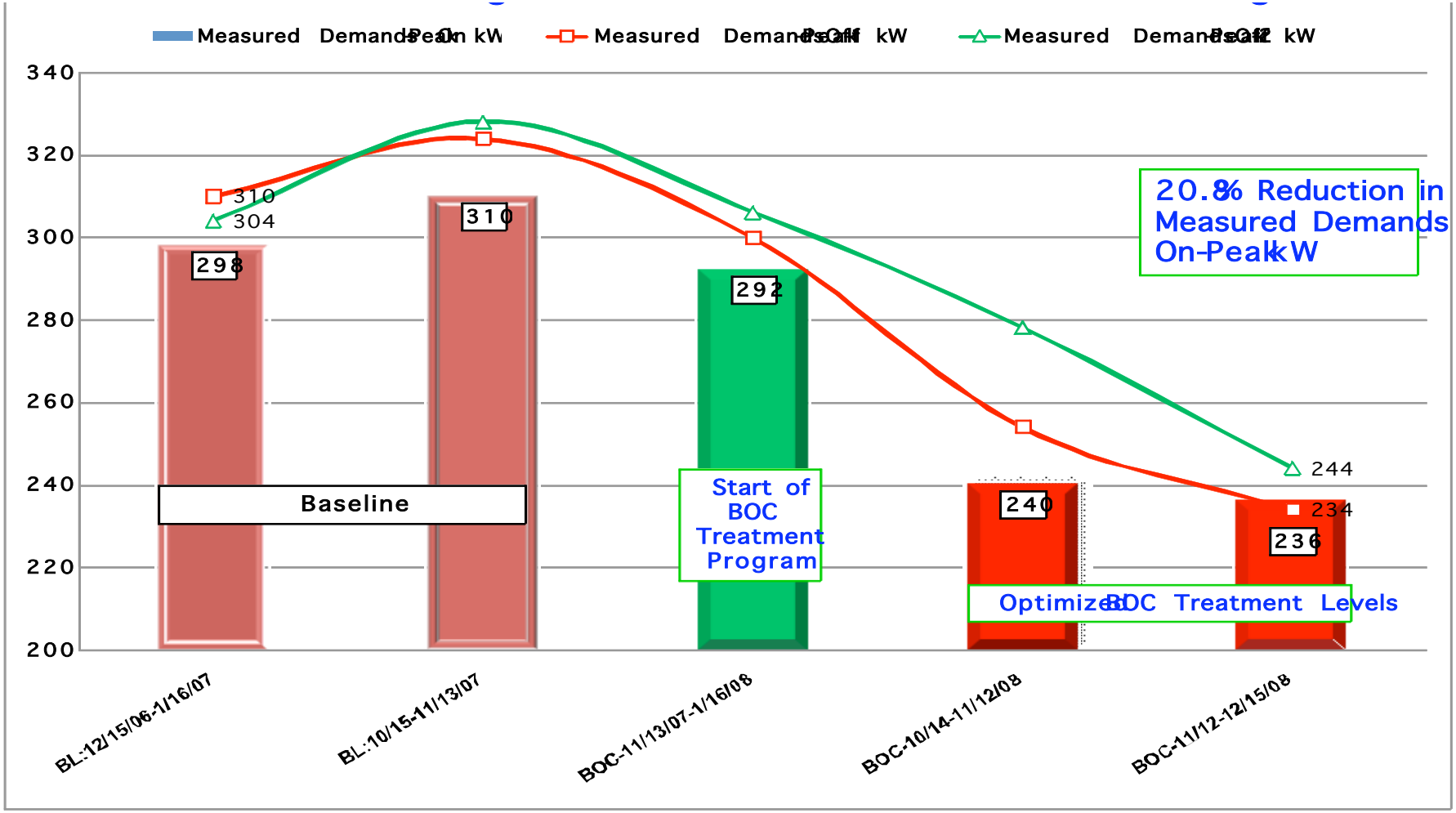
There is a reduction of energy consumption within the facility's aeration channels from the "carry-over-effect" of the BOC injection into the anaerobic digester (AD) as the sludge thickening supernatant is returned to the front end influent wastewater, thereby enhancing the transfer of dissolved oxygen in secondary aeration channels.

- This aeration energy savings provides an important secondary economic value to the BOC process optimization of the anaerobic digester (AD) application.
- The aeration energy savings offers the wastewater operator an additional energy conservation strategy within a volatile energy marketplace.
- Overall aerobic processes and BNR exhibit positive performance characteristics due to improvement of transfer of dissolved oxygen and management of optimum dissolved oxygen levels.

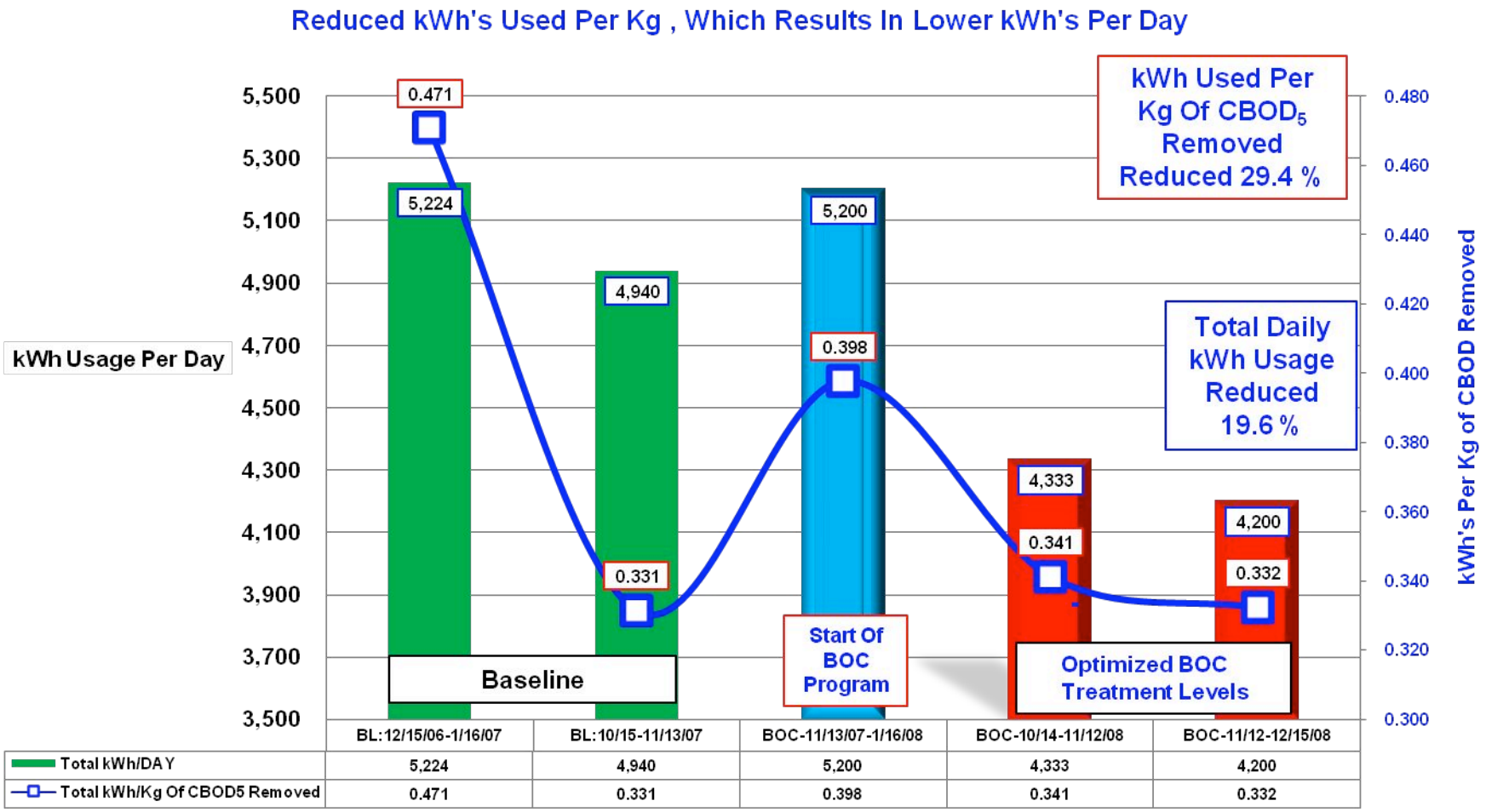
Reduction Of Secondary Aeration Energy

- 20.8% reduction in Measured Demand On-Peak 1 kW.
- 24.5 % reduction in Measured Demand Off-Peak 1 kW.
- 19.7% reduction in Measured Demand Off-Peak 2 kW.
- 29.4% reduction in total kWh's per Kg of $CBOD_5$ removed.
- 20% reduction in kWh's used per day.

Reducing Measured Peak and Off Peak kWh Usage



Reduced kWh's Usage Per Day, per Kg



Secondary Aeration Energy Savings Per Day & Annually

Based on the average prior baseline kWh usage of 5,224/day and the reduction of 1,000 kWh per day, daily and annual electrical savings are calculated as follows:

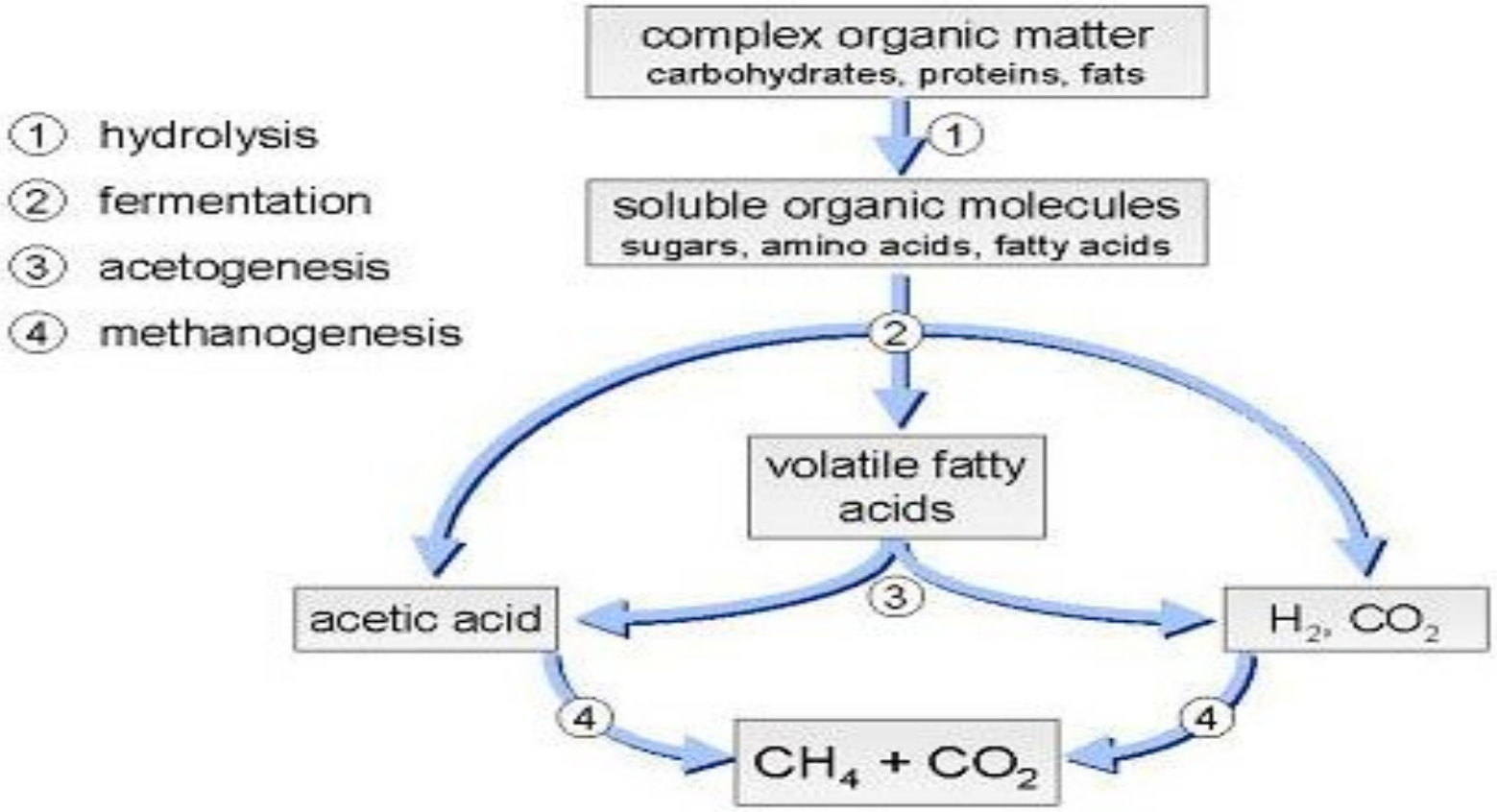
The average daily energy cost (kWh) during the early baseline period (12/15/06-1/16/07) was $.099/kWh, during which 5,224 kWh's were used. The prior average daily energy cost per day was $519.64.

During the BOC Optimization period the average daily energy cost rose to $.1327/kWh, or the equivalent of $693.22 per day

At a savings of 1,000 kWh daily, this translates to a savings of $132.67 per day, and a savings of $48,424.55 per year.

Anaerobic Digestion Optimization With BOC

The Anaerobic Digestion Sequence



Anaerobic Digestion Optimization with BOC

- The bio-catalytic action of BOC on the various organic components of a sludge waste stream, including the lipids, indicates that there is an accelerated release of high nutrient values to indigenous microbiological populations within the bio-digester system.
- This leads to a faster transition to the Methanogenesis phase, along with higher microbiological vigor, producing a more complete biological consumption of TS & TVS.
- This study showed a correlation to biomethane yield improvements and TS & TVS consumption rates. This 1 year study demonstrates these trend lines as optimization is reached.
- Distinct qualitative characteristics of sludge discharged from AD exhibited substantial odor reductions, which follows from a more complete consumption of TVS components.

Summary Of Results

Summary Of BOC Anaerobic Digestion Optimization

- 62% increased biogas production produced an annual savings of $38,500 in NG purchases against the baseline period.
- Increased biomethane yields offer potential further annual NG savings of $24,500 - $31,000 through a reduction, or elimination, of NG usage in Building Boiler.
- 29.3% reduction of sludge volumes offers projected savings annually of $18,945.38.
- Reduction of secondary aeration energy usage on total kWh's used per Kg of $CBOD_5$ has been reduced by 29.4%, for a savings of $132.67 per day, or a savings of $48,424.55 per year.

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